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## 'Planting time' is an important factor in increasing the yield and the quality of early potatoes in Western Kazakhstan

SL Ismatullayev<sup>1\*</sup>, EE Braun<sup>1</sup>, SE Suleymenova<sup>2</sup>, RS Sarsengaliev<sup>1</sup>, AK Kushenbekova<sup>1</sup>

<sup>1</sup>West Kazakhstan Agrarian Technical University named after Zhangir Khan, Uralsk, 090009, Zhangir Khan Street, 43/1, Kazakhstan.

<sup>2</sup>Kazakhstan National Agrarian University, Almaty, Abay Ave 8, 050010, Kazakhstan.

\*Corresponding author: West Kazakhstan Agrarian Technical University named after Zhangir Khan, Uralsk, Kazakhstan.

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### Abstract

Empirically found that in western Kazakhstan, where there is a rapid increase in temperature in spring, planting dates act as an independent agronomic factor, accelerating the growth and development of potato plants, which contributes to early accumulation of tuber harvest of high quality. This paper presents the results of studying the effect of planting time of the promising variety Udacha and the standard variety Nevsky on the yield and quality parameters of potato in the conditions of western Kazakhstan. The results of the conducted researches showed that planting dates have a great influence on the growth processes of potato plants, as well as on the duration of the interphase periods. When planted in April, the plants form powerful developed bushes, more good leafed stems, the aboveground mass increases, as well as the assimilation leaf surface and the intensity of photosynthesis, which contributes to the accumulation of early harvest of a high quality tubers. When planted in April, the crop yield of the variety Nevsky in July 20 reaches 30.6 t/ha, and variety Udacha reaches 33.5 t/ha.

**Keywords:** Potato; planting dates; assimilation area; the intensity of photosynthesis; marketability; crop yield.

### Introduction

The climate of western Kazakhstan is sharply continental, it is characterized by sunny, quite hot summer, a relatively cold winter, and small rainfall.

During the transition spring period, simultaneously with the temperature increase, the rainfall increases. However, the rainfall is not enough and it cannot cover the water consumption on evaporation. In these conditions, when the period of a favorable combination of temperature, soil and air humidity is short, we should not delay the planting of tubers.

The most dangerous to the potatoes are late spring frosts, which are possible at night, especially during the so-called "returns of cold weather". In west Kazakhstan region, frosts usually stop in the first half of May, but low intensity frosts (-0.7-0.2°C) are observed in about 20% of the years and in the second half of May. The finalization date of the late spring frosts while growing potato, especially early varieties for summer consumption, is particularly important, since its tops are damaged by relatively small temperature drops below zero.

The danger of late spring frosts for the newly risen potato is low, since the light late spring frosts with an intensity of up to -1.5°C in the shoots phase do not have a considerable adverse effect on tuber yield.

When planted in April 20-30, seedlings appear in mid-May and the likelihood of frost damage to them is very low. Frosts in these dates are short (observed only at night and sometimes lasting only a few minutes), and do not cause severe damage to the shoots.

Our previous studies have shown that the yield decreases with delayed planting [1-3]. Yield reduction in delayed planting regardless of the precocity and the type of planting material (seeds, microtubers) are given in refs. [4-8]. Therefore, it is of great interest to study the effect of planting dates on the crop yield of early potatoes.

### Materials and Methods

To determine the optimum planting time, which provides early production for summer consumption in 2009-2011 years at the department of

“Plant growing and farming” of the Faculty of Agronomy of the West Kazakhstan Agrarian Technical University named after Zhangir Khan special experiments were conducted on the lands of LLP “Izdenis” in Zelenovsky District of West Kazakhstan region; three planting dates were studied: April 20 (very early), April 30 (early), and 10 May (normal).

Two varieties were studied: middling early variety Nevsky (homologated) and promising early variety Udacha.

Planting was carried out using tubers germinated under light for 30-40 days, weighing 50-80 g, according to the scheme  $70 \times 25$  cm, sowing depth of the tubers is 6-8 cm.

The experiments were made using a systematic method with tier disposition of the options in the experience. The total area of the experimental plot was 84 m<sup>2</sup>, the accounting one – 56 m<sup>2</sup>, with a fourfold replication.

In the experiments potatoes were placed after a well-fertilized cucumber under irrigation. In the Autumn, September, they made under-winter ploughing to a depth of 27-30 cm. In under-winter ploughing they placed superphosphate (120 kg d.v.) and potassium chloride (60 kg/ha ai). During spring, at the same time with the cultivation, they placed ammonium nitrate (60 kg d.v.).

The soil cover is represented by dark brown medium loamy soils folded into powerful loamy deposits, not saline, the humus content in arable horizon reaches 3.6%. The total nitrogen content in the soil ranged from 0.298 to 0.308%; movable phosphorus – 3.2-3.8 mg; potassium – 51.6-61.2 mg per 100 g of soil and pH 7.0-7.1.

During the growing period for all variants of the experiment, phenological observations were carried out daily. Plant density was calculated after the full shoots and before the harvest on all plots in all experiment replicates.

Plant height was determined by measuring ten consecutive standing bushes every 10 days on each plot in all experiment replicates. The dynamic of accumulation of the plant tops was determined by weighing ten typical bushes from each plot of all versions according to their development phases in dynamic diggings. The first was carried out 50 days after planting, the second – 10 days after the first. In the dynamic diggings, we determined the mass of plant tops, the number of stems, leaves, their weight, the number of tubers, their weight, the assimilation surface of the leaves, and the intensity of photosynthesis.

In laboratory conditions, the following quality indicators of the tubers were determined: the solid substance was determined by drying a sample of average tubers to constant weight at 105°C, the starch content in the tubers was determined by specific weight on the VLKT-500 balance, Vitamin C was determined according to Prokoshev, sugar was determined according to Bertrand, protein content in tubers was determined by photocolometric method using the dye orange “F”, the nitrate content was determined by the potentiometric method using ion-selective electrodes [9].

Harvest accounting was carried out by overall harvest and weighing on balances. To determine the structure of the crop before overall harvest, we removed in each plot in all occurrences 10 typical bushes.

Harvest data were processed by variance analysis [10].

## Results and Discussion

The research results showed that the time of planting has a significant influence on the duration of individual interphase periods, on the growth of plants, on the accumulation of the total aboveground mass, on the number of stems and leaves on the bush, their weight, and on the formation of the leaf surface.

Photosynthetic potential is one of the most important indicators of the work of the assimilation apparatus of plants in crops, which depends on the speed and power of forming of the leaf surface and the duration of its functioning.

Some researchers [11] assert that the study of the photosynthetic activity of the crops specifically for each crop, taking into account all the factors of plant life is very important for the purposeful cultivation of high yields.

Our experiments showed that planting dates had some influence not only on the number of stems and leaves but also on the formation of the leaf surface. But the formation of leaf apparatus was also influenced by weather conditions (Table 1).

So, for the variety Nevsky the greatest assimilation surface of one plant was obtained in 2011 and it was at the first planting time 71.5 dm<sup>2</sup>, which is higher than in 2009 by 5.3 dm<sup>2</sup>, in comparison with 2010 by 10.7 dm<sup>2</sup>; in the second – 75.2 dm<sup>2</sup> or more in comparison with previous years, respectively, by 9.0 and 9.8 dm<sup>2</sup>;

**Table 1: The effect of planting time on the photosynthetic processes of the varieties Nevsky and Udacha in western Kazakhstan (2009-2011).**

Variety	Planting dates	Assimilation surface		Intensity of photosynthesis mg/dm <sup>2</sup> /h
		dm <sup>2</sup> /bush	Thousand. m <sup>2</sup> /ha	
Nevsky	20 April	66.1	37.7	8.40
	30 April	68.9	39.3	9.09
	10 May	63.6	36.3	8.43
Udacha	20 April	74.0	42.2	8.85
	30 April	71.6	40.8	9.24
	10 May	68	39.1	8.37

at third planting time – 65.4 dm<sup>2</sup>, which is more than in the previous year by 3.2 dm<sup>2</sup> and 2.0 dm<sup>2</sup>.

A similar pattern is observed in the variety Udacha. But in this variety the assimilation area was generally larger than it was in the variety Nevsky. Thus, on average over 3 yrs in the first planting time it was 74.0 dm<sup>2</sup>, that is, more than in the variety Nevsky by 7.9 dm<sup>2</sup>; in the second – 71.6 dm<sup>2</sup>, that is, more by 2.7 dm<sup>2</sup>; in the third – 68.0 dm<sup>2</sup> or more than in the variety Nevsky by 4.4 dm<sup>2</sup>.

These data strongly suggest that the formation of the assimilating surface is influenced by the planting dates, weather conditions, and biological characteristics of the variety.

Assimilating surface of the leaves in the variety of Nevsky per hectare in the first planting date ranged from 34.7 to 40.8 thousand, M<sup>2</sup> on average over 3 yrs – 37.7 thousand. M<sup>2</sup>, in the second, from 37.3 to 42.9 thousand, m<sup>2</sup>/ha.

On the variety Udacha, these figures were slightly higher and on average of 3 yrs in the first date of planting they exceed the data of the variety Nevsky by 4.5 thousand, m<sup>2</sup>/ha, while in the second planting time by 1.5, and in the third by 2, 8 thousand, m<sup>2</sup>/ha.

Potato yield is in 90-95% formed by photosynthesis, so the assimilation leaf surface area is one of the main indicators characterizing the state of the plantings [12].

In the optimal conditions, the productivity of photosynthesis in potatoes is 7-9 g/m<sup>2</sup> in a day, and in cloudy or very hot weather it reduces to zero [13].

However, as we know, the crop yield of plants depends not only on the mass of plant tops but also on the energy of photosynthesis.

Observations have shown that the intensity of photosynthesis is related to weather conditions, on the one hand, and, on the other hand, to the biological feature of the variety and planting dates.

So, at early planting date (April 20) the intensity of photosynthesis of the variety Nevsky in 2009 was 8.01 mg/dm<sup>2</sup>/h; in 2010 – 8.16 mg/dm<sup>2</sup>/h; in 2011 – 9.03 mg/dm<sup>2</sup>/h, which is less than in the second planting time, respectively, by 0.32 mg/dm<sup>2</sup>/h, 0.66 mg/dm<sup>2</sup>/h, and 0.91 mg/dm<sup>2</sup>/h.

In the variety Udacha, photosynthetic intensity was higher and the excess averaged over 3 yrs in the first planting time 0.45 mg/dm<sup>2</sup>/h, in the second – 0.15 mg/dm<sup>2</sup>/h, and in the third – it was less by 0.03 mg/dm<sup>2</sup>/of an hour. Therefore, the early variety negatively reacts to late planting time.

The data on the dynamics of formation of total and commodity yield are of a great practical interest, especially in the production of early potatoes for summer consumption (Figures 1 and 2).

**Figure 1: The crop yield of potato tubers 50 days after planting, t/ha (2009-2011).**

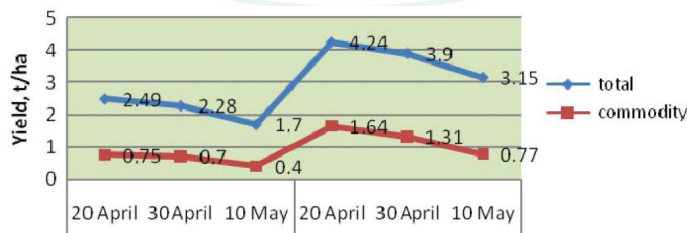
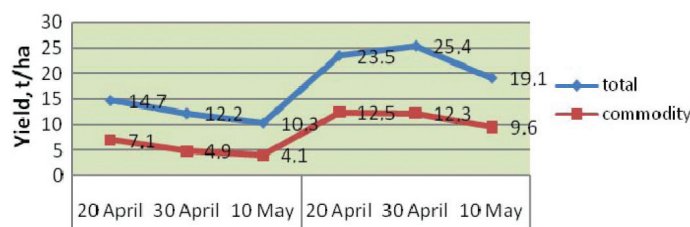


Figure 2: The crop yield of potato tubers 60 days after planting, t/ha (2009-2011).



So, 50 days after planting tuber yield at April planting was significantly higher than in May planting dates.

The total yield of the variety Udacha was higher. In the first planting time in 2009 it was 4.09 t/ha, in the second – 4.25 t/ha, in the third – 4.40 t/ha, which is more than in the variety Nevsky by 1.9 t/ha, 1.71 t/ha, and 1.65 t/ha.

A similar regularity was observed in 2010 and in 2011. In determining the commodity harvest the regularity is observed.

Sixty days after planting, the crop yield increased in all planting dates, but it was the highest in the first planting date.

The average of 3 yrs yield of the variety Nevsky at the first planting time increased by

12.21 t/ha, in the second – 9.9 t/ha, in the third – 8.6 t/ha, and for the variety Udacha – by 21.26, 21.5, and 15.9 t/ha, respectively.

The effect of planting dates on the yield of early potatoes can also be seen in the final harvesting on July 20 (Table 2).

The analysis of yield data shows that in the first and second planting dates there is no significant difference. In the third planting time, there is a significant decline in yields for both varieties.

Planting dates had a definite impact on the quality of tubers, which is of a great importance in solving actual problems of the development of early potatoes production (Table 3).

Structural analysis of the crop showed that the marketability of the tubers at all planting

Table 2: Crop yield of early potatoes in the final harvesting on 20 July.

Variety	Planting dates	Crop yield, t/ha			The average of 3 yrs
		2009	2010	2011	
Nevsky	20 April	27.9	28.2	32.4	29.5
	30 April	28.8	30.4	32.8	30.6
	10 May	25.4	25.8	26.6	25.9
Udacha	20 April	31.3	32.4	35.7	33.3
	30 April	30.8	33.8	35.9	33.5
	10 May	27.1	26.2	28.5	27.2
	LSD <sup>I</sup>	3.32	1.29	0.95	1.78
	LSD <sup>II</sup>	1.93	0.74	0.55	1.03
	LSD <sup>III</sup>	2.36	0.91	0.68	0.56

Table 3: The effect of planting time on the qualitative indicators of the potato crop in the varieties Nevsky and Udacha in western Kazakhstan (2009-2011).

Variety	Planting dates	Marketability %	Solids %	Starch %	Vitamin C, mg per 100 g of raw mass	Protein, %	Sugar, %	Nitrates, mg/kg
Nevsky	20 April	91.4	21.9	15.9	19.0	2.4	0.34	91.8
	30 April	92.1	22.8	15.8	19.1	2.3	0.33	96.4
	10 May	89.3	21.1	14.9	19.7	2.2	0.31	102.1
Udacha	20 April	95.3	24.0	14.7	19.5	2.4	0.31	89.7
	30 April	95.3	24.6	14.7	19.8	2.3	0.28	92.0
	10 May	90.7	21.6	13.3	20.8	2.2	0.26	95.7

times was very high and its level was defined by the planting time, as well as by weather conditions during the growing season.

The marketability of the variety Udacha was higher than that in the variety Nevsky in the first planting time in average of 3 yrs at 3.9%, in the second – at 3.2, and in the third – at 1.4%.

Solids content in tubers of the Udacha variety was slightly higher than in the tuber of the variety Nevsky. This excess averaged in 3 yrs in the first planting time 2.1%, in the second – 1.8%, and in the third – 0.50%.

Some researchers [14,15] have reported that approximately 83% of solids in potato is starch. They assert that the identification of varietal and agronomic features of the accumulation of starch in tubers of a great practical importance, because food, fodder, and technical value of potatoes increase, also its storing capacity improves.

The starch content in tubers varied between varieties, it also depended on the time of planting, as well as on weather conditions during the growing period.

Potatoes contain a set of useful vitamins for human beings, especially water-soluble, but their amount in tubers is exposed to large variations. Of particular importance is the relatively high content of vitamin C [16], its content in the tubers largely depends on the weather conditions, and on the varietal characteristics [17].

The analysis of vitamin C content indicates that in young tubers its content is higher than in ripe ones.

Studies have also shown that the planting time and weather conditions during the growing period have some influence on the content of sugars in the tubers. As the planting time is delayed there is a slight decrease in sugar content.

The same regularity is observed in the variety Udacha, but this variety contains a lower amount of sugar.

The protein content in tubers was low. In average over 3 yrs the highest protein content (2.4%) was found in both varieties at the first planting time.

The lowest nitrate content in the tubers was found in the potato planted on April 20, with an average in 3 yrs tubers the variety Nevsky contained 91.8 mg/kg, in the tubers of the variety Udacha – 89.1 mg/kg. When planted on May 10 in an average of 3 yrs nitrate content in tubers of the variety Nevsky was 102.1 mg/kg, in the

tubers of the variety Udacha – 95.7 mg/kg, which is below the maximum permissible concentration (250 mg/kg).

## Conclusion

The planting dates have a great influence on the growth processes of potato plants, as well as on the duration of the interphase periods. When planted in April the plants form powerful developed bushes, more good leafed stems, the aboveground mass increases, as well as the assimilation leaf surface, and the intensity of photosynthesis, which contributes to the accumulation of an early harvest of high quality tubers.

When planted in April the crop yield of the variety Nevsky in July 20 reaches 30.6 t/ha, the variety Udacha – 33.5 t/ha.

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